

DATA COMMUNICATION APPARATUS, METHOD AND SYSTEM
AND PROGRAMS FOR DATA COMMUNICATION PROCESS
STORED IN COMPUTER READABLE STORAGE MEDIUM

5 BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a data communication apparatus, method and system, and to programs for a data communication process stored in a computer readable storage medium. More particularly, 10 the invention relates to data communication techniques using communication control buses capable of dealing with mixed control and data signals.

Related Background Art

15 A need for using an apparatus dealing with still or moving images, such as AV (audio visual) apparatuses, as a peripheral apparatus of a personal computer has recently become strong. The AV apparatuses include a digital video tape recorder (D-VTR), a digital video tape recorder with a built-in camera (D-CAM), a digital camera, and the like. For 20 such needs, a system has been developed which can connect such AV apparatuses to PC and can process and edit in various ways digital signals of still and 25 moving images taken with AV apparatuses. Another system has also been developed in which PC can record still and moving image signals from AV apparatuses in a

recording medium such as a hard disk, and can print such images with an image printing apparatus such as a printer.

In order to reduce the amount of still and moving
5 image data to be transferred between apparatuses constituting such a system, the image data is converted into compressed data by using various compression encoding techniques. For example, a JPEG (Joint Photographic Experts Group) method is known for still
10 images, and an MPEG (Moving Picture Experts Group) method is known for moving images. These compression encoding methods are realized by a combination of DCT techniques and variable length coding techniques, while taking into consideration the characteristics and
15 features of image data to be compressed.

Fig. 1 is a block diagram showing the structure of a conventional communication system. In Fig. 1, reference numeral 101 represents a D-CAM (recording/reproducing device), 102 represents a
20 printer, and 103 represents a PC. PC 103 and the printer 102 are interconnected by communication interfaces of SCSI (small computer system interface) specifications. PC 103 and D-CAM 101 are interconnected by dedicated communication interfaces.

25 In the communication system shown in Fig. 1, for example, the following processes have been executed in printing a still image contained in moving images

reproduced with D-CAM 101.

PC 103 temporarily stores moving image data sequentially output from D-CAM 101 in a storage device such as a hard disk. Next, PC 103 reproduces the
5 moving images by using a predetermined application, and selects a desired still image of one frame from the moving images. In this case, a user performs a special effect process for the selected still image, if necessary, and thereafter instructs to print the still
10 image. In response to this instruction, PC 103 supplies the still image data to the printer 102 connected thereto via a communication interface different from that for D-CAM 101. Lastly, the printer 102 prints out the still image. As above, the
15 communication system shown in Fig. 1 prints a still image contained in moving images with the help of PC 102.

With the communication system described above, however, in order to select a desired still image
20 contained in moving images produced with D-CAM 101, the moving image is required to be temporarily stored in the storage device such as a hard disk of PC 103. PC 103 then reproduces moving image data stored in the storage device to select a desired still image.

25 In the conventional communication system, therefore, a large amount of data such as moving image data is sequentially sent to PC 103 each time in the

unit of a predetermined amount of data, so that a load
of PC 103 is very large. Depending upon the process
performance and condition of PC 103 itself or upon a
communication state of each apparatus, PC 103 may
5 become inoperative or adversely affect the
communication with other apparatuses. Furthermore,
since a desired still image is selected after the
moving image data stored in PC 103 is reproduced, it
takes a long time to print the still image.

10 In the communication system shown in Fig. 1, in
order to reduce the amount of moving image data to be
transmitted from D-CAM 101 to PC 103, the moving image
data is compressed at D-CAM 101 by a predetermined
compression encoding scheme, and the compressed data is
15 transmitted to PC 103.

However, even if D-CAM 101 transmits compressed
moving image data, a desired still image cannot be
selected unless PC 103 itself can expand and decode the
compressed moving image data.

20 In the communication system shown in Fig. 1, if
moving image data irrelevant to the compression coding
scheme used by PC 103 is to be transmitted, D-CAM 101
has conventionally transmitted non-compressed moving
data itself to PC 103.

25 However, if PC 103 has an expansion decoding
scheme corresponding to the compression encoding scheme
of D-CAM 101, a transmission efficiency is lowered

unnecessarily and a load on PC 103 is increased.

SUMMARY OF THE INVENTION

An object of the present invention is to solve the
5 above-described problems.

Another object of the invention is to provide a
data communication apparatus in which an encoding
process for information data to be transmitted is
performed in accordance with a decoding performance at
10 an object node apparatus, to thereby improve the
communication efficiency and reduce a capacity of a
memory used for communications.

As a preferred embodiment for such objects, the
invention discloses a data communication apparatus
15 which comprises: (a) communication means having a first
mode of transmitting information data isochronously
with a predetermined communication cycle and a second
mode of transmitting information data asynchronously
with the predetermined communication cycle; (b)
20 encoding means for encoding the information data by a
predetermined encoding method; and (c) control means
for controlling the communication means so as to
transmit encoded information data when the encoding
method corresponds to a decoding method at an object
25 node apparatus and to transmit non-encoded information
data when the encoding method does not correspond to
the decoding method at the object node apparatus.

As another embodiment, the invention discloses a data communication apparatus which comprises: (a) communication means having a first mode of communication isochronous with a predetermined communication cycle and a second mode of communication asynchronous with the communication cycle; (b) encoding means for encoding image information in accordance with a decoding performance at an object node apparatus, the image information including moving image information and still image information; and (c) control means for controlling the communication means so as to transmit the moving image information by using the first mode and to transmit the still image information by using the second mode.

As another embodiment, the invention discloses a data communication apparatus which comprises: (a) input means for inputting moving image information and still image information; (b) encoding means for encoding the moving image information and the still image information; and (c) transmitting means for transmitting the moving image to a number of unidentified apparatuses and transmitting the still image information to a designated apparatus.

As another embodiment, the invention discloses a data communication apparatus which comprises: (a) input means for inputting information data; (b) encoding means for encoding the information data; and (c)

transmitting means for transmitting decode information containing program codes realizing the decoding method corresponding to an encoding method to be used by the encoding means and transmitting the information data
5 encoded by the encoding means.

As another embodiment, the invention discloses a data communication apparatus which comprises: (a) input means for inputting encoded information data and decode information realizing a decoding process for the
10 information data; and (b) decoding means for decoding the encoded information data by using the decode information.

As another embodiment, the invention discloses a data communication apparatus which comprises: (a) encoding means for encoding information data by using a predetermined encoding method; (b) decoding means for decoding information data encoded by the encoding means; and (c) selecting means for selecting an output of either the encoding means or the decoding means in
15 accordance with whether the encoding method corresponds to a decoding method at an object node apparatus.
20

Another object of the present invention is to provide a data communication method in which an encoding process for information data to be transmitted is performed in accordance with a decoding performance
25 at an object node apparatus, to thereby improve the communication efficiency and reduce a capacity of a

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memory used for communications.

As a preferred embodiment for such an object, the invention discloses a data communication method which comprises the steps of: (a) encoding information data by a predetermined encoding method; (b) transmitting encoded information data isochronously with a predetermined communication cycle when the encoding method corresponds to a decoding method at an object node apparatus; and (c) transmitting non-encoded information data asynchronously with the communication cycle when the encoding method does not correspond to the decoding method at the object node apparatus.

As another embodiment, the invention discloses a data communication method which comprises the steps of: (a) encoding image information in accordance with a decoding performance at an object node apparatus, the image information including moving image information and still image information; (b) transmitting the moving image information by using a communication scheme isochronous with a predetermined communication cycle; and (c) transmitting the still image by the communication scheme isochronous with the communication cycle or by a communication scheme asynchronous with the communication cycle.

As another embodiment, the invention discloses a data communication method which comprises the steps of: (a) inputting moving image information and still image

information; (b) encoding the moving image information and the still image information; and (c) transmitting the moving image to a number of unidentified apparatuses and transmitting the still image information to a designated apparatus.

As another embodiment, the invention discloses a data communication method which comprises the steps of:
(a) inputting information data; (b) encoding the information data; and (c) transmitting decode information containing program codes realizing the decoding method corresponding to an encoding method to be used at the encoding step and transmitting the information data encoded at the encoding step.

As another embodiment, the invention discloses a
15 data communication method which comprises the steps of:

(a) inputting encoded information data and decode
information realizing a decoding process for the
information data; and (b) decoding the encoded
information data by using the decode information.

20 As another embodiment, the invention discloses a
data communication method which comprises the steps of:

(a) encoding information data by using a predetermined
encoding scheme; (b) decoding information data encoded
at the encoding step; and (c) selecting an output of
either the encoded information data or the decoded
information data in accordance with whether the
encoding scheme corresponds to a decoding scheme at an

object node apparatus.

Another object of the present invention is to provide a data communication system in which an encoding process for information data to be transmitted 5 is performed in accordance with a decoding performance at an object node apparatus, to thereby improve the communication efficiency and reduce a capacity of a memory used for communications.

As a preferred embodiment for such an object, the 10 invention discloses a data communication system having a first mode of transmitting information data isochronously with a predetermined communication cycle and a second mode of transmitting information data asynchronously with the predetermined communication 15 cycle, wherein encoded information data is transmitted when a predetermined encoding scheme corresponds to a decoding scheme at an object node apparatus and non-encoded information data is transmitted when the encoding scheme does not correspond to the decoding 20 scheme at the object node apparatus.

As another embodiment, the invention discloses a data communication system having a first mode of communication isochronous with a predetermined communication cycle and a second mode of communication 25 asynchronous with the communication cycle, wherein moving image information encoded in accordance with a decoding performance at an object node apparatus is

transmitted by using the first mode and still image information encoded in accordance with the decoding performance at the object node apparatus is transmitted by using the first or second mode.

5 As another embodiment, the invention discloses a
data communication system, comprising: (a) a
transmission apparatus for transmitting decode
information containing program codes realizing a
decoding method corresponding to a predetermined
10 encoding method and transmitting information data
encoded by using the encoding method; and (b) a
reception apparatus for receiving the decode
information and the information data and decoding the
information data by using the decode information.

15 Another object of the present invention is to provide a program for a data communication process stored in a computer readable storage medium, in which an encoding process for information data to be transmitted is performed in accordance with a decoding performance at an object node apparatus, to thereby improve the communication efficiency and reduce a capacity of a memory used for communications.

As a preferred embodiment for such an object, the invention discloses a program for a data communication process stored in a computer readable storage medium, comprising the steps of: (a) encoding information data by a predetermined encoding method; (b) transmitting

encoded information data isochronously with a predetermined communication cycle when the encoding method corresponds to a decoding method at an object node apparatus; and (c) transmitting non-encoded
5 information data asynchronously with the communication cycle when the encoding method does not correspond to the decoding method at the object node apparatus.

As another embodiment, the invention discloses a program for a data communication process stored in a computer readable storage medium, comprising the steps of:
10 (a) encoding image information in accordance with a decoding performance at an object node apparatus, the image information including moving image information and still image information; (b) transmitting the
15 moving image information by using a communication scheme isochronous with a predetermined communication cycle; and (c) transmitting the still image by the communication scheme isochronous with the communication cycle or by a communication scheme asynchronous with
20 the communication cycle.

As another embodiment, the invention discloses a program for a data communication process stored in a computer readable storage medium, comprising the steps of:
25 (a) inputting moving image information and still image information; (b) encoding the moving image information and the still image information; and (c) transmitting the moving image to a number of

unidentified apparatuses and transmitting the still image information to a designated apparatus.

As another embodiment, the invention discloses a program for a data communication process stored in a computer readable storage medium, comprising the steps of: (a) inputting information data; (b) encoding the information data; and (c) transmitting decode information containing program codes realizing the decoding method corresponding to an encoding method to be used at the encoding step and transmitting the information data encoded at the encoding step.

As another embodiment, the invention discloses a program for a data communication process stored in a computer readable storage medium, comprising the steps of: (a) inputting encoded information data and decode information realizing a decoding process for the information data; and (b) decoding the encoded information data by using the decode information.

As another embodiment, the invention discloses a
20 program for a data communication process stored in a
computer readable storage medium, comprising the steps
of: (a) encoding information data by using a
predetermined encoding scheme; (b) decoding information
data encoded at the encoding step; and (c) selecting an
output of either the encoded information data or the
25 decoded information data in accordance with whether the
encoding scheme corresponds to a decoding scheme at an

object node apparatus.

Still other objects of the present invention, and the advantages thereof, will become fully apparent from the following detailed description of the embodiments.

5

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic diagram showing the structure of a conventional communication system.

Fig. 2 is a schematic diagram showing the 10 structure of a communication system according to a first embodiment of the invention.

Fig. 3 is a schematic diagram showing an example of a communication system in conformity with IEEE 1394 specifications.

15 Fig. 4 is a diagram showing constituents of a 1394 interface.

Fig. 5 is a diagram showing the address space of a 1394 interface.

20 Fig. 6 is a cross sectional view of a communication cable in conformity with IEEE 1394 specifications.

Fig. 7 is a diagram illustrating a DS-Link coding scheme.

25 Fig. 8 is a schematic diagram showing an example of a communication system in conformity with IEEE 1394 specifications.

Fig. 9 is a flow chart illustrating the processes

from bus reset to the start of data transfer.

Fig. 10 is a flow chart illustrating the processes of discriminating a parent/child relationship (membership) of communication ports at respective nodes.

Fig. 11 is a flow chart illustrating the processes of automatically setting a node ID of each node.

Figs. 12A and 12B are diagrams illustrating arbitration of a 1394 interface.

Fig. 13 is a diagram showing a time sequential transition state during asynchronous transmission.

Fig. 14 shows an example of a packet format used by asynchronous transmission.

Fig. 15 is a diagram showing a time sequential transition state during isochronous transmission.

Fig. 16 shows an example of a packet format used by isochronous transmission.

Fig. 17 is a diagram illustrating both isochronous and asynchronous transmissions in one communication cycle.

Fig. 18 is a diagram showing the details of the structure of the communication system shown in Fig. 2.

Fig. 19 is a flow chart illustrating the operation of the recording/reproducing device shown in the first embodiment.

Fig. 20 is a flow chart illustrating the exemplary operation of the communication system of the first

embodiment.

Fig. 21 is a diagram illustrating moving image and still image data transmitted in the communication system of the first embodiment.

5 Fig. 22 is a diagram showing the structure of a communication system according to a second embodiment of the invention.

Fig. 23 is a flow chart illustrating the exemplary operation of the communication system of the second 10 embodiment.

Fig. 24 is a diagram illustrating moving image and still image data transmitted in the communication system of the second embodiment.

15 Fig. 25 is a diagram showing the structure of a monitor shown in the second embodiment.

Fig. 26 is a schematic diagram showing the structure of a communication system according to third and fourth embodiments of the invention.

20 Fig. 27 is a diagram showing the details of a recording/reproducing device and a printer shown in the third and fourth embodiments.

Fig. 28 is a flow chart illustrating the exemplary operation of the recording/reproducing device shown in the third embodiment.

25 Fig. 29 is a flow chart illustrating the exemplary operation of the recording/reproducing device shown in the fourth embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The preferred embodiments of the present invention will now be described in detail hereinafter with reference to the accompanying drawings.

5 1. First Embodiment

Fig. 2 is a diagram showing a communication system according to a first embodiment of the invention. This communication system can perform communications in conformity with IEEE 1394-1995 specifications
10 (hereinafter called IEEE 1394 specifications).

Apparatuses constituting the communication system shown in Fig. 2 have communication interfaces in conformity with IEEE 1394 specifications (hereinafter called 1394 interfaces). The apparatuses are
15 interconnected by communication cables in conformity with IEEE 1394 specifications.

Technologies of IEEE 1394 specifications will be briefly described. The details of IEEE 1394 specifications are given in "IEEE 1394-1995 Standard
20 for a High Performance Serial Bus" published by IEEE (Institute of Electrical and Electronics Engineers).

<Summary>

Fig. 3 shows an example of a communication system in conformity with IEEE 1394 specifications. This
25 communication system configures a bus type network capable of serial data communications.

In Fig. 3, apparatuses A to H are interconnected

by twist pair cables in conformity with IEEE 1394 specifications. Examples of these apparatuses are a PC (Personal Computer), a digital VTR (Video Tape Recorder), a DVD (Digital Video Disc) player, a digital camera, a hard disk, a monitor and the like.

As the interconnection method for the communication system shown in Fig. 3, daisy chain and node branch are both used so that a high degree of connection freedom is possible.

The communication system shown in Fig. 3 automatically executes a bus reset (a process of resetting the past network configuration and re-recognizing the new network configuration) when any apparatus is disconnected from the network, when a new apparatus is connected to the network, or when the power of an apparatus connected to the network is turned on or off. With this bus reset, the communication system can automatically assign each apparatus with its specific ID, or each apparatus constituting the communication system can automatically recognize the network connection. With these functions, the 1394 network can recognize the network configuration at any time.

The communication system shown in Fig. 3 has a function of relaying data from one apparatus to another, and each apparatus can recognize the bus operation state at the same time. Furthermore, the

communication system has a function called Plug & Play so that an apparatus connected to the network or the connection state of the network can be automatically recognized without turning the power of the whole network off.

The communication system shown in Fig. 3 can deal with the data transmission rates of 100/200/400 Mbps. The apparatus having a higher transmission rate supports the apparatus having a lower transmission rate to make them compatible.

The communication system shown in Fig. 3 has two different data transmission modes including an asynchronous transmission mode and an isochronous transmission mode. The asynchronous transmission mode is suitable for transmitting data required to be asynchronously transmitted when necessary (such as control signals and file data). The isochronous transmission mode is suitable for transmitting data required to be transmitted continuously at a predetermined data rate (such as video data and audio data). Both the asynchronous and isochronous transmission modes may be used in each communication cycle (generally 125 μ s). Each transmission mode is executed after a cycle start packet (CSP) indicating the start of a cycle is transmitted. In each communication cycle period, the isochronous transmission mode has a priority order higher than the

asynchronous transmission mode. The transmission bandwidth of the isochronous transmission mode is ensured or reserved in each communication cycle.

<Architecture>

5 The constituents of an 1394 interface are shown in Fig. 4.

The 1394 interface is functionally configured to have a layer (hierarchical) structure. As shown in Fig. 4, reference numeral 401 represents a 10 communication cable in conformity with IEEE 1394 specifications. This cable 401 is connected via a connector port 402 of the 1394 interface to a physical layer 403 and to a link layer 404 in a hardware portion.

15 The hardware portion is substantially an interface chip. Of the hardware portion, the physical layer 403 controls a bus reset, encoding/decoding of input/output signals, and the like. The link layer 404 generates a communication packet, controls a cycle timer, and 20 performs other operations.

A transaction layer 405 of a firmware portion performs management of data to be transmitted and manages Read and Write transactions. A serial bus management 406 performs the management of connection 25 state and ID of each apparatus connected to the system to thereby manage the network configuration and information.

These hardware and software are the substantial structure of the 1394 interface.

An application layer 407 shown in Fig. 4 becomes different depending upon software to be used. This layer defines how data is communicated over the communication system. For example, in the case of moving image data of a D-VTR, data communication is defined in accordance with a communication protocol such as an AV/C protocol.

10 <Address Designation>

Fig. 5 shows an address space of the 1394 interface.

Addressing of an 1394 interface is in conformity with IEEE 1212 which defines an address space of a 64-bit width. In addressing, the first 10-bit field is used for designating a bus ID number, and the next 6-bit field (502) is used for designating the apparatus (node) ID. These upper 16 bits are used for identifying a node ID and for communications between nodes. The remaining 48-bit field designates an address space assigned to the apparatus. In this field, a 20-bit field (403) designates a plurality areas constituting the address space (i.e., an initial memory space, a private space, a register space). The last 28-bit field (404) designates an address for a specific data area in which information of apparatus discrimination (company name, apparatus type and the

like) and use condition is stored.

<Structure of Communication Cable>

Fig. 6 is a cross sectional view of a communication cable in conformity with IEEE 1394
5 specifications.

The communication cable has power lines in addition to two pairs of twist pair signal lines. Therefore, an apparatus without a power source or an apparatus with a power supply voltage lowered by some
10 trouble can be supplied with power via the power lines by the 1394 interface.

A communication cable of a 4-pin type may also be used without using power lines. It is stipulated that a power supply voltage at the power line is 8 to 40 V,
15 and a current is DC 1.5 A at a maximum.

Signals encoded by DS-Link (Data/Strobe Link) coding scheme are transmitted over the two pairs of twist pair signal lines.

Fig. 7 illustrates the DS-Link (Data/Strobe Link)
20 coding scheme.

This DS-Link coding scheme is suitable for high speed serial data communications. It is necessary to use two pairs of signal lines. One pair of two twist pair signal lines is used for transmitting data
25 signals, and the other of two twist pair signal lines is used for transmitting strobe signals.

On the reception side, a clock can be retrieved by an exclusive logical sum of the transmitted data and

strobe signals.

The merits of the DS-Link coding scheme are as follows. A transmission efficiency is higher than other coding schemes. Since a PLL circuit is not necessary, the scale of a controller LSI can be made small. Since it is not necessary to transmit information representative of an idle state when there is no data to be transmitted, a transceiver circuit of each equipment can enter a sleep state and a power consumption can be lowered.

<Bus Reset Sequence>

The 1394 interface recognizes the network configuration by assigning each apparatus (node) connected to the network with a node ID.

When the network configuration varies with, for example, a change in the number of nodes to be caused by node connection/disconnection or power turn-on/off, and it becomes necessary to recognize a new network configuration. A node which detected a change transmits a bus reset signal to the bus to enter a mode of recognizing a new network configuration. This change is detected by a change in a bias voltage applied to the communication port 402.

When the bus reset signal is transmitted from a node to the network, the physical layer 403 of each node notifies the link layer 404 of a bus reset occurrence, and transmits the bus reset signal to other

nodes. After the bus reset signal is transmitted to all nodes, a bus reset (i.e., a process of initializing the connection state and re-recognizing a new connection state) is activated.

5 The bus reset may be activated through hardware detection of a cable connection/disconnection, a network abnormality or the like and through a direct command issued to the physical layer 403 under host control using a protocol.

10 As the bus reset is activated, data transmission is temporarily stopped and enters a standby state. After the completion of the bus rest, the data transmission resumes under the new network configuration.

15 <Sequence of Node ID Determination>

20 In order to recognize the new network connection state after the bus reset, the 1394 interface executes a process of setting a node ID (constituted of a bus number and a node number) to each node. A general sequence from the start of a bus reset to the end of setting a node ID will be described with reference to Figs. 8 to 11.

25 Fig. 8 is a diagram illustrating the exemplary operation of a communication system in conformity with IEEE 1394 specifications. In the example shown in Fig. 8, each node is connected to the same bus so that the same bus number is used for each node.

Referring to Fig. 8, reference numeral 801 represents a node A having one communication port, reference numeral 3002 represents a node B having two communication ports, reference numeral 803 represents a 5 node C having two communication ports, reference numeral 3004 represents a node D having three communication ports, reference numeral 805 represents a node E having one communication port, and reference numeral 3006 represents a node F having one 10 communication port. The communication port of each node is assigned a port number for discriminating between ports.

With reference to the flow chart shown in Fig. 9, the processes to be executed by the communication 15 system shown in Fig. 8, from the bus reset to the data transfer start, will be described.

In Fig. 9, each node A to F constituting the communication system always monitors whether a bus reset occurs in the network. When a bus reset signal 20 is output because of a change in the network configuration to be caused by, for example, a node power on-off, each node executes the following processes.

Each node declares a membership determination of 25 its communication ports in order to re-recognize the new connection state of the network (Step S902). Each node of the network repeats the process at Step S902

until the membership between all nodes is determined (Step S903). After the membership between all nodes on the network is determined, the communication system determines a node which arbitrates the network, i.e., a
5 root (Step S904).

After the root is determined, the 1394 interface automatically assigns each node with a node ID (Step S905). The root repeats the process at Step S905 until all nodes are assigned with node IDs in accordance with
10 a predetermined procedure (Step S906). After all nodes are assigned with node IDs, the 1394 interface executes data transmission between nodes (Step S907).

After the process at Step S907, the 1394 interface monitors again an occurrence of a bus reset, and when a
15 bus reset occurs, the processes from Step S901 are executed.

In the above manner, with the 1394 interface, all nodes can recognize the network configuration through automatic assignment of each node ID by the root
20 determined at each bus reset.

Fig. 10 is a flow chart illustrating the details of the process at Step S902 shown in Fig. 9, i.e., the process of recognizing the membership between node communication ports.

25 Referring to Fig. 10, each node A to F constituting the communication system confirms in response to the bus reset the connection state

(connection or disconnection) of its communication port or ports, in order to judge whether the node is a leaf (node connected to only one apparatus) or a branch (node connected to a plurality of apparatuses) (Step 5 S1001). The number of communications ports connected to other nodes is counted (Step S1002).

If it is judged at Step S1002 that the number of connected ports is "1", the node recognizes itself as a leaf (Step S1003). This leaf node declares to the node 10 connected to the port that "I am a child and you are a parent" (Step S1004). The leaf recognizes its connection port as a "child port".

Declaration of the membership between communication ports can be made by a leaf node, because 15 the leaf node has only one connected port, i.e., the leaf node is an outermost terminal of the network. The membership between communication ports is determined sequentially in the order of faster declaration, in which the communication port at the declaring 20 communication node is determined as a child port and the communication port at the declared communication node is determined as a parent port. For example, in the example shown in Fig. 8, the nodes A, E and F recognize themselves as a leaf and thereafter declare 25 the membership. Therefore, a child-parent membership is determined between nodes A-B, a child-parent membership is determined between nodes E-D, and a

child-parent membership is determined between nodes F-D.

If it is judged at Step S1002 that the number of connected ports is "2" or larger, this node recognizes itself as a branch (Step S1005). The branch node receives the membership declaration from each node connected to its connection port (Step S1006). The connection port received the declaration is recognized as the parent port.

After the parent port is recognized, the branch checks whether there is any connection port (undefined port) whose membership is still not determined (Step S1007).

If there is an undefined port at Step S1007, it is checked whether the number of undefined ports is "1" (Step S1008). If "1", the branch recognizes the undefined port as the child port and declares to the node connected to the port that "I am a child and you are a parent" (Step S1009).

The branch cannot declare to another node that "I am a child" until the number of remaining undefined ports becomes "1". In the example shown in Fig. 8, the nodes B, C and D recognize themselves as a branch, and receive a declaration from another branch or leaf.

After the memberships between D-E and D-F are determined, the node D declares the membership to the node C. Upon reception of the declaration from the

node D, the node C declares the membership to the node
B.

If the number of undefined ports is larger than
"1" at Step S1008, the branch executes again the
5 process at Step S1006.

If there is no undefined port at Step S1007 (if
all connection ports of the branch become parent
ports), the branch recognizes itself as the root (Step
S1010).

10 In the example shown in Fig. 8, the node B whose
all connection ports are parent, is recognized by other
nodes as a node for arbitrating the communication
system. Although it is assumed in this example that
the node B is determined as the root, another node may
15 become a root node if the membership declaration timing
of the node B is faster than that of the node C.
Namely, depending upon the declaration timing, any node
has a possibility of becoming a root. Therefore, the
same node is not necessarily a root in the same network
20 configuration.

With the above processes, the membership for all
nodes is determined so that the communication system
can recognize the connection state in the form of a
hierarchical structure (tree structure). The parent in
25 the membership is at a higher hierarchical level and
the child is at a lower level.

Fig. 11 is a flow chart illustrating the details

of the process at Step S905 shown in Fig. 9, i.e., the process of automatically setting the node ID (bus number and node number) of each node.

Referring to Fig. 11, the root permits a node to
5 set a node ID, the node being connected to a communication port of the root and having a minimum number among its connection ports (Step S1101). After all nodes connected to the connection port having the minimum number are given node IDs, the root performs
10 similar controls relative to the node connected to the next minimum port number. In this manner, the root node is given the last node ID. The node numbers contained in the node IDs are assigned "0", "1", "2",... basically in the order from leafs to branches.
15 Therefore, the root has the largest node number.

The permitted node checks whether there is a parent port (communication port connected to a child node) still not set with the node ID (Step S1102).

If there is a parent port still not set with the
20 node ID at Step S1102, the node permits the node connected to the minimum port number to set a node ID (Step S1103).

The node permitted at Step S1103 checks whether there is a parent port still not set with the node ID
25 (Step S1104).

If it is checked at Step S1104 that there is a parent port still not set with the node ID, the

permitted node executes again the process at Step S1103.

If there is no communication port still not set with the node ID at Step S1102 or at Step S1104, the
5 permitted node sets its own node ID (Step S1105). The first node which first permitted the second node determines that the communication port of the first node has already been set.

The node which completed the node ID setting
10 broadcasts a self ID packet containing its node ID information and its communication port connection state (Step S1106). The term "broadcast" means to transmit a communication packet from one node to all the nodes constituting a communication system. Upon reception of
15 this self ID packet, each node can recognize the node ID assigned to each node.

For example, in the example shown in Fig. 8, the root node B permits the node A connected to the communication port with the minimum port number "#1" to
20 set the node ID. The node number of the node A is therefore set to "No. 0", and the node A broadcasts the self ID packet containing the node number.

After the process at Step S1106, the node which set the node ID checks whether there is a parent node
25 (Step S1107). If there is a parent node, the parent node again executes the processes starting from Step S1102 to give a permission to the node still not set

with the node ID.

If there is no parent node, this node is judged to be the root. The root checks whether all nodes constituting the communication system were set with the node IDs (Step S1108).

If it is judged at Step S1108 that all nodes constituting the communication system are still not set with the node IDs, the root permits the node connected to the communication port with the next minimum port to set the node ID (Step S1101). Thereafter, the processes starting from Step S1102 are executed.

If all nodes were set with the node IDs, the root sets its own node ID (Step S1109). Thereafter, the root broadcasts a self ID packet (Step S1110) to terminate the node ID setting procedure.

With the above processes, the communication system can automatically assign each node with a node ID.

<Arbitration>

Figs. 12A and 12B illustrate arbitration of the 1394 interface. In Figs. 12A and 12B, a node B is a root, nodes A and C are branches, and nodes D, E and F are leaves.

With the 1394 interface, prior to data transmission, arbitration for a bus use privilege is performed necessarily. With the 1394 interface, a logical bus type network can be configured in which a communication packet transmitted to each node is

5 relayed to another node to allow the communication packet to be transmitted to all nodes in the network system. Therefore, in order to prevent collision of communication packets, it is essential to perform arbitration. With this arbitration, only one node can transmit data at a time,

Fig. 12A is a diagram illustrating the case wherein nodes C and F issue a request for bus use privilege. As arbitration starts, the nodes C and F 10 issue a bus use privilege request to the parent node. Upon reception of the request from the node F, the parent node (i.e., node A) further issues a bus use privilege request to its parent node (i.e., relays the request from the node F). This request reaches the 15 root (node B) which performs final arbitration.

The root received the bus use privilege request determines which node can use the bus. This arbitration work can be performed only by the root node, and the node succeeded the arbitration is given a bus use privilege. In the example shown in Fig. 12B, the node C is permitted to use the bus, and the request from the node F is rejected.

20 The root transmits a DP (data prefix) packet to the node which failed the arbitration to thereby inform the node of a failure. The rejected node stands by until the next arbitration for the bus use privilege.

25 By controlling the arbitration in the above

manner, the communication system can control the use of the bus by each node.

<Asynchronous Transmission Mode>

The asynchronous transmission transmits data 5 asynchronously. Fig. 13 shows a time sequential transition during the asynchronous transmission.

The first subaction gap shown in Fig. 13 indicates an idle state of the bus. When this idle time reaches a constant value, the node intending to transmit data 10 judges that the bus can be used, and executes an arbitration for acquiring the bus.

If a use permission is obtained by the arbitration, the data in a packet format is transmitted. After the data transmission, the node 15 received the asynchronous packet returns back an ack (reception confirmation return code) or a response packet after a short ack gap. The ack is constituted of four-bit information and four-bit check sums including information of a success, failure, or pending 20 state, and is returned immediately to the transmission source node.

Fig. 14 shows an example of the packet format used by the asynchronous transmission. A communication packet transmitted in the asynchronous transmission 25 mode is called an asynchronous packet.

Referring to Fig. 14, an asynchronous packet includes a header field 1401, a header CRC 1402, a data

field 1403, and a data CRC 1404. The header field 1401 includes a field 1405 for storing an object node ID, a field 1406 for storing a source node ID, a field 1407 for storing a packet format and data for discriminating between processes to be executed (i.e., transaction code (tcode)), and other fields.

The asynchronous transmission is peer-to-peer communications between its own node and a partner node. A packet transmitted from the transmission source node 10 is transmitted to each node of the network. However, the packet transmitted to each node and not having an address of the node is discarded, so that only one node having the object node address can read the packet.

<Isochronous Transmission>

15 The isochronous transmission transmits data synchronously. This mode is suitable particularly for real time data transmission required for multi media data such as video and audio data. Although the asynchronous transmission is peer-to-peer transmission, 20 this isochronous transmission can broadcast a packet from one transmission source to all other nodes, by using the broadcast function. The isochronous transmission does not use the ack (reception confirmation return code).

25 Fig. 15 shows a time sequential transition during the asynchronous transmission. In this embodiment, a communication packet transmitted during the isochronous

transmission mode is called an isochronous packet.

Referring to Fig. 15, the isochronous transmission mode is executed each communication cycle. The communication cycle period is generally 125 μ s. A cycle start packet is transmitted at the start of each communication cycle. This cycle start packet has a roll of adjusting time at each node. The cycle start packet is transmitted to all nodes after a predetermined idle period (subaction gap) after the completion of each communication cycle. One communication cycle period is a period from the transmission of a preceding cycle start packet to the reception of the succeeding cycle start packet.

In the example shown in Fig. 15, channels A, B and C represent bandwidths of different isochronous packets. With the 1394 interface, different channel numbers are assigned in order to discriminate between a plurality of different isochronous packets. It is therefore possible to transmit a plurality of isochronous packets to a plurality of nodes. This channel ID does not indicate the object node address, but it is only a logical number of data.

The iso gap (isochronous gap) shown in Fig. 15 is an idle period necessary for the recognition of an idle state of the bus prior to performing the isochronous transmission mode. After this idle period lapses, a node intending to perform isochronous transmission

judges that the bus is idle and arbitration can be performed before the transmission.

The isochronous transmission mode is necessarily performed at each cycle in order to preserve real time

5 transmission.

Fig. 16 shows an example of the format of a packet used during the isochronous transmission mode.

Referring to Fig. 16, an isochronous packet includes a header field 1601, a header CRC 1602, a data field 1603 and a data CRC 1604. The data field 1603 includes a field 1605 for storing data representative of a data length, a field 1606 for storing data representative of a channel number of an isochronous packet, a field 1607 for storing a packet format and data (i.e., transaction code (tcode)) for discriminating between processes to be executed, and other fields.

<Bus Cycle>

Both the isochronous and asynchronous transmission mode can be performed in each communication cycle.

Fig. 17 shows a time sequential transition of both the isochronous and asynchronous transmissions in one communication cycle.

The isochronous transmission mode is performed with a priority over the asynchronous transmission mode. The reason for this is that the isochronous transmission can be performed after the cycle start

packet, with a shorter gap length (isochronous gap) necessary for the isochronous transmission than a gap length (subaction gap) of the idle period necessary for performing the asynchronous transmission. The
5 isochronous transmission is therefore performed with a priority over the asynchronous transmission.

Referring to Fig. 17, at the start of the communication cycle #m, a cycle start packet is transmitted to each node. Each node performs time
10 adjustment by using this packet.

After the isochronous gap, a node intending to perform isochronous transmission transmits an isochronous packet. In the example shown in Fig. 17, isochronous packets of a channel e, a channel s and a
15 channel k are transmitted after each isochronous gap.

After the isochronous packet is transmitted for a predetermined time period, each node can transmit the asynchronous packet. The asynchronous transmission by each node is executed after the subaction gap. The
20 period while the asynchronous transmission can be performed, is during the period after the isochronous transmission and before the time (cycle synch) when the next cycle start packet is transmitted.

If it becomes the time (cycle synch) when the next
25 cycle start packet is transmitted while the asynchronous packet is transmitted, the asynchronous packet is not forcibly intercepted, but after the

completion thereof, the next cycle start packet is transmitted. If one communication cycle continues longer than 125 μ s, the next communication cycle period is shortened correspondingly.

5 The structure and function of the communication system using 1394 interfaces have been described above.

<Direct Print System using IEEE 1394 Specifications>

With reference to Fig. 2, a direct print system using IEEE 1394 specifications will be described.

10 In Fig. 2, reference numeral 201 represents a digital VTR integrated with a camera as a recording/reproducing device capable of recording/reproducing digital image data of a predetermined format (e.g., SD-VTR, MPEG) on/from a

15 recording medium. The digital VTR integrated with a camera 201 can converts digital image data stored in a recording medium into a packet and transmit it to an external apparatus in accordance with a predetermined procedure. Reference numeral 202 represents a printer capable of printing digital image data reproduced with the digital VTR integrated with a camera 201, and reference numeral 203 represents a monitor capable of displaying still and moving images transmitted from the digital VTR integrated with a camera 201.

20 The communication system shown in Fig. 2 is illustrative only, and the connection state may be changed as desired different from that shown in Fig. 2,

or various other apparatuses may be connected to this system. Apparatuses connected to this system may be other electronic apparatuses such as a hard disk, a CD player, a DVD player, so long as they can conform with
5 IEEE 1394 specifications and can configure a network.

With reference to Fig. 18, the structure of the communication system shown in Fig. 2 will be described in detail.

In a recording/reproducing device (a digital VTR integrated with a camera) 201 shown in Fig. 18, reference numeral 4 represents an image pickup unit, 5 represents an A/D converter, 6 represents an image processing unit, 7 represents a compression/expansion unit for performing a compression encoding during recording and an expansion decoding during reproducing in accordance with a predetermined algorithm, 8 represents a recording/reproducing unit for recording/reproducing moving or still images on/from a recording medium 19 with a recording/reproducing head or the like, 9 represents a system controller having a microcomputer and a memory for storing predetermined program codes, 10 represents an operation unit for entering information to control the digital VTR integrated with a camera 201, 11 represents a D/A converter, 12 represents an EVF (Electric View Finder) used for displaying a reproduced image or a picked-up image, 13 represents a memory for temporarily storing
10
15
20
25

non-compression encoded image data of N frames, 14
represents a memory controller for controlling timings
of reading data from, or writing data into, the memory
13, 15 represents a memory for temporarily storing
5 compression encoded image data of N frames, 16
represents a memory controller for controlling timings
of reading data from, or writing data into, the memory
15, 17 represents a data selector for selecting outputs
of the memories 13 and 15, 18 represents a 1394
10 interface for performing communications in conformity
with IEEE 1394 specifications, and 19 represents a
recording medium of a magnetic tape. In the first
embodiment, the digital VTR integrated with a camera
using a magnetic tape as its recording medium is used.
15 Instead a digital camcorder using an optical disk, a
solid state memory and the like may also be used as the
recording medium.

In a printer 202 shown in Fig. 18, reference
numeral 19 represents a 1394 interface of the printer
20 202, 20 represents a data selector for selecting either
control data or image data, 21 represents a decoding
unit for decoding image data compression encoded with a
predetermined algorithm, 22 represents an image
processing unit for forming a print image, 23
25 represents a memory used by the image processing unit
22 when a print image is formed, 24 represents a
printer head, 25 represents a drive for driving the

printer head and feeding a recording sheet, 26
represents a printer controller for controlling each
part of the printer 202, and 27 represents an operation
unit for entering information for controlling the
5 printer.

In a monitor 203 shown in Fig. 18, reference
numeral 61 represents a 1394 interface of the monitor
203, 62 represents an expansion/decoding unit for
expansion decoding video data compression encoded by a
10 predetermined algorithm, 63 represents a D/A converter,
64 represents a CRT, 65 represents a system controller
for controlling each part of the monitor 203, and 66
represents an operation unit for entering information
for controlling the monitor 203. In the first
15 embodiment, in addition to the above components, the
monitor 203 is equipped with a circuit for receiving
and displaying a known television signal.

Next, the operation of each apparatus constituting
the communication system shown in Fig. 2 will be
20 described.

<Operation of Recording/Reproducing Device 201>

In a "record mode", an analog image signal
(including moving and still images) picked up with the
image pickup unit 4 is digitalized by the A/D converter
25 5 and processed by the image signal processing unit 6.
One output (standard television signal of NTSC format)
of the image signal processing unit 6 is converted into

analog signals of the image now being taken by the D/A converter and displayed by EVF 12. The other output is compression encoded by the compression/expansion unit 7 in accordance with a predetermined algorithm and
5 recorded in the recording medium by the recording/reproducing unit 8. The compression encoding includes a JPEG format used by digital cameras or the like, a compression format based on DCT (discrete cosine transform) and VLC (variable length coding) used
10 by home digital VTRs or the like, an MPEG format, and the like.

In a "reproduce mode", the recording/reproducing unit 8 reproduces a desired image stored in the recording medium. In this case, a desired image is
15 selected in accordance with a user instruction entered from the operation unit 10, and reproduced under the control of the system controller 9. If the image data reproduced by the recording medium is to be transmitted in the compression state, the reproduced data is stored in the memory (frame memory) 15. If the image data is
20 to be transmitted in the non-compression state, the reproduced data is expansion decoded by the compression/expansion unit 7 and stored in the memory 13. If the reproduced image data is to be displayed by
25 EVF 12, it is expanded by the compression/expansion unit 7, converted into analog signals by the D/A converter 11, and supplied to EVF 12 to display images.

Read/write of the frame memories 13 and 15 is controlled by the memory controllers 14 and 16 under the control of the system controller 9. The read image data is supplied to the data selector 17. In this
5 case, the data selector 17 is controlled to select one of the outputs from the frame memories 13 and 15 at a time.

Although the system controller 9 controls each part of the recording/reproducing device 201, it can
10 also perform the following control. Namely, it generates command data for controlling the printer 202 and monitor 203 and asynchronously transmits the command to the printer and monitor via the data selector 17 and 1394 interface 18. It also controls
15 each part of the recording/reproducing device 201 by using various command data asynchronously transmitted from the printer 202 and monitor 203. For example, a command data indicating a presence/absence of a decoder or the type of a decoder asynchronously transmitted
20 from the printer 202 or monitor 203 is supplied as a request command to the system controller 9.
Thereafter, in accordance with the command data, it is judged whether image data of either compression or non-compression is to be transmitted from the
25 recording/reproducing device 201. In accordance with this judgement, a command is transmitted to the memory controller 14, 16 to read proper one of the image data

from the frame memory 13, 15.

The judgement whether image data of either compression or non-compression is to be transmitted is performed in accordance with the information of a decoder of the printer 202 or monitor 203. If it is judged from the decoder information that the compression encoding of the recording/reproducing device 201 can be decoded, the compression encoded image data is read from the memory 15, whereas if it is judged that the compression encoding cannot be decoded, the non-compression encoded image data is read from the memory 13.

The image data and command data supplied to the data selector 17 are transmitted by the 1394 interface 18 to the cable in accordance with the IEEE 1394 specifications, and received by the printer 202 if the image data is the print still image data, or by the monitor 203 if the image data is the display moving image data. The command data is also asynchronously transmitted to a desired node when necessary. Real time data mainly moving image data and audio data is isochronously transmitted, whereas command data is asynchronously transmitted. Among data generally isochronously transmitted, some data may be asynchronously transmitted depending upon the transmission conditions or if asynchronous transmission is preferable.

20100000000000000000000000000000

<Operation of Printer 202>

In operation of the printer 202, data input to the 1394 interface 19 is classified into respective types of data by the data selector 20. Data to be printed
5 such as still image and compression encoded is expansion decoded by the decoding unit 21 and thereafter output to the image processing unit 22. As described earlier, the recording/reproducing device 201 transmits data by selecting either compression encoding
10 or non-compression encoding so as to have optimum transmission, in accordance with the previously transmitted information of a presence/absence of a decoder or the type of a decoder. Therefore, if the transmitted data was compression encoded, the decoding
15 unit 21 of the printer 202 can expansion decode the received data in a method corresponding to the compression encoding. If the transmitted data was non-compression encoded, this case corresponds to either the case that the printer 202 has no decoding unit 21
20 or the case that the printer 202 has the decoding unit 21 which cannot deal with the compression of the recording/reproducing device 201. In such a case, the received data is directly supplied to the print image processing unit 22 without passing through the decoding
25 unit 21. If not the image data but the command data for the printer 202 is input, it is not necessary to expansion decode it, so that the decoding unit 21 is

not used.

For example, print still image data input to the image processing unit 22 is processed so as to make it suitable for printing and generate print image data by 5 using the memory 23 whose read/write is controlled by the printer controller 26. This print image data is sent to the printer head 24 and printed out. Driving the head of the printer 202 and feeding a recording sheet are performed by the driver 25, and the control 10 of the driver 25 and printer head 24 and other controls are performed by the printer controller 26.

The operation unit 27 has a monitor circuit for displaying a paper feed state, reset state, ink check state, and printer 202 operation state (standby, start, 15 stop), and informs a user of these states. In accordance with the displayed information, the user operates upon the operation unit 27 to control each part of the printer 202.

Next, if the data input to the 1394 interface 19 20 is command data for the printer 202, a notice to this effect is informed from the data selector 20 to the printer controller 26. The printer controller 26 then controls each part of the printer 202 so as to follow the instruction of the command data.

25 The printer controller 26 can output information of the type of a decoder of the decoding unit 21 or the presence/absence of the decoding unit 21 of the printer

202, and can transmit it asynchronously as the command data to the recording/reproducing device 201.

The expansion decoding of the decoding unit may be, for example, a JPEG format. Decoding of the JPEG format can be performed by software. Therefore, by using a JPEG decoding program file stored in a ROM of the decoding unit 21 or by using a decoding program transmitted from another node, the decoding unit 21 may decode the received data by software. For example, if the image data compression encoded by the JPEG format is transmitted from the recording/reproducing device 201 to the printer 202, this image data can be decoded by the printer 202 so that the transmission efficiency can be improved more than non-compression data is transmitted. By using decoding through software, the printer 202 is not necessary to have a decoder, lowering manufacture cost. The decoding unit 21 may have a JPEG decoding circuit (board) as hardware.

As described above, a so-called direct print is performed without using a management apparatus such as a PC, when still image data is transmitted from the recording/reproducing device 201 to the printer 202.

<Operation of Monitor 203>

Next, the processes to be performed at the monitor 203 will be described. Moving image data transmitted from the recording/reproducing device 201 to the 1394 interface 61 of the monitor 203 is supplied to the

expansion decoding unit 62. The expansion decoding unit 62 expansion decodes the moving image data by using an expansion decoding method having a predetermined algorithm.

5 In the monitor 203, in accordance with an instruction input from the operation unit 66, the system controller 65 controls each part of the monitor 203.

The moving image data transmitted to the monitor
10 203 is compressed or non-compressed so as to have optimum transmission, in accordance with the previously transmitted information of a presence/absence of a decoder or the type of a decoder which the recording/reproducing device 201 received, similar to
15 the case of the printer 202. Therefore, even if the received moving image data is compression encoded data, this received data can be decoded through expansion decoding having a predetermined algorithm corresponding to the expansion decoding unit 62 of the monitor 203.

20 In displaying the moving image data on CRT 64, if the data is compressed encoded data, it is expansion decoded by the expansion decoding unit 62 and thereafter supplied to the D/A converter 63 to be displayed on CRT 64, whereas if it is non-compression
25 encoded data, it is directly supplied to the D/A converter 63 and displayed on CRT 64.

For example, the expansion decoding unit 62 of the

monitor 203 may be a dedicated hardware board capable of performing a decoding process for an MPEG format for example, or a ROM storing program codes which perform a decoding process for an MPEG format or a JPEG format through software. The type or presence/absence of such a decoder is transmitted from the monitor 203 to the recording/reproducing device 201.

With the structure constructed as above, prior to transmitting the moving or still image data from the recording/reproducing device 201 to the printer 202 or monitor 203, the recording/reproducing device 201 can receive the information of a decoder of the printer 202 or monitor 203 asynchronously transmitted.

Accordingly, in accordance with the performance of the decoder at an object node, the recording/reproducing device 201 selectively transmits compression encoded image data itself if it can be decoded, or non-compression image data if the encoded data cannot be decoded.

20 <Transmission Sequence of Image Data>

Next, with reference to the flow chart of Fig. 19, the operation of the recording/reproducing device 201 when image data (including moving and still images) is transmitted, will be described.

25 Fig. 19 illustrates a mode of transmitting image data from the recording/reproducing device 201 to another apparatus via the 1394 interfaces. First, at

Step S1 the recording/reproducing device 201 performs data transmission setting for an object node in accordance with a user's designation. At Step S2, the recording/reproducing device 201 asynchronously transmits a command to an object node, the command including predetermined information notifying the object node of that transmission will starts soon and information urging the object node to transmit the information of a presence/absence, type and the like of a decoder. Upon reception of the command transmitted at Step S2, the object node asynchronously transmits to the recording/reproducing device 201 a predetermined transmission confirmation command data including decoder information.

Upon reception of the transmission confirmation command data, the system controller 9 of the recording/reproducing device 201 checks whether the decoder information was able to receive. If the decoder information was received and the presence and type of the decoder was able to identify, the flow advances to Step S4. On the other hand, the flow advances to Step S6 if the received command data does not contain the decoder information, if it contains information indicating that the decoder is not present, or if the command data is not transmitted from the object node or is not received until a predetermined time lapse because of a bus transmission error or

asynchronous transmission delay.

The decoder information contained in the command data transmitted from the object node to the source node or recording/reproducing device 201 is used for judging whether image data to be compressed and stored is transmitted or is non-compressed and thereafter transmitted. Namely, the decoder information has a roll of informing the source node of that the object node wants to receive either compressed data or non-compressed data. Therefore, if the object node, e.g., monitor 203 already knows the information of the compression scheme used by the source node or recording/reproducing device 201, a command requesting to receive either compressed image data or non-compressed image data may be returned in response to the command data transmitted at Step S2 from the recording/reproducing device 201, instead of returning the command data containing the decoder information of the monitor 203.

Next, at Step S4 if the type of the decoder judged from the received decoder information corresponds to the decoder which can deal with the compression encoding having a predetermined algorithm used by the compression/expansion unit 7 of the recording/reproducing device 201, then the recording/reproducing device 201 judges that the object node can decode image data. Thereafter, at Step S5 the

recording/reproducing device 201 controls an output of
the memory 15 in order to isochronously or
asynchronously transmit the compression encoded image
data. If it is judged at Step S4 that the type of the
5 decoder cannot deal with the compression encoding used
by the recording/reproducing device 201 or if the
decoder information was not able to receive at Step S3
(i.e., if it is judged that there is no decoder at the
object node), then at Step S6 the recording/reproducing
10 device 201 expansion decodes the image data. In order
to isochronously or asynchronously transmit non-
compressed image data, the recording/reproducing device
201 controls an output of the memory 13.

After the output format is set in accordance with
15 the type of the object node as described above, at Step
S7 the user selects moving images stored in the
recording medium 19 in order to print or display it.
The recording/reproducing device 201 reads the selected
moving image. After the image is selected, at Step S8
20 the user instructs a transmission of the desired image.

Next, in accordance with the setting at Step S5 or
S6, it is checked at Step S9 whether the object node
has a decoder. If it has, at Step S10 the compressed
image data reproduced from the recording medium 19 is
25 transmitted. Specifically, in response to the
transmission instruction at Step S8, the system
controller 9 and memory controller 16 control an output

read from the memory 15. If the object node has no decoder, at Step S11 non-compressed image data expanded at the compression/expansion unit 7 is transmitted. Specifically, in response to the transmission
5 instruction at Step S8, the system controller 9 and memory controller 16 control an output read from the memory 13. In this embodiment, a packet of moving image data is transmitted by the isochronous transmission in conformity with IEEE 1394
10 specifications, and a packet of still image data is transmitted by the asynchronous transmission.

When desired image data is transmitted at Step S12, it is checked at Step S13 whether other image data is to be transmitted. If other image data is selected,
15 the processes at Step S7 and following Steps are repeated. If other image data is not selected, the flow advances to Step S14 whereat it is judged whether the image data transmission mode continues by changing an object node. If it continues, the processes at Step
20 S1 and following Steps are repeated. If it is judged at Step S14 that the mode is not necessary to be continued with a changed an object node, this flow is terminated. This flow starts from Step S1 in response to a transmission response of moving or still images.

25 As described above, in this embodiment, the recording/reproducing device 201 acquires information of which decoding method an object node has, from the

object node to which image data is to be transmitted. If it is judged from the acquired information that the recording/reproducing device encodes image data by a procedure corresponding to the decoding method of the 5 object node, then image data encoded by the corresponding encoding procedure is transmitted, whereas if it is judged contrarily, encoded image data is decoded and thereafter transmitted. Accordingly, even if the source node uses any type of a decoding 10 method, encoded data corresponding to the decoding method can be reliably transmitted. If the same encoding and decoding methods are used by an object node, encoded data can be transmitted and received so that communications can be speeded up. The capacity of 15 a memory required for transmission/reception can be reduced if decoded data is transmitted.

In the first embodiment, it is judged whether encoded data reproduced from the recording medium 19 is to be transmitted directly or after it is decoded, in 20 accordance with the decoding performance of the object node. The invention is not limited only thereto. For example, it may be judged whether data still not stored in the recording medium 19 is to be transmitted directly or after it is encoded.

25 Next, with reference to the flow chart shown in Fig. 20, another operation will be described in which moving image data taken with, for example, the digital

VTR integrated with a camera 201 is isochronously transmitted and a still image contained in the moving images is printed with the printer 202.

In the first embodiment, the decoding unit 21 of
5 the printer 202 does not match the encoding method of a still image generated by the digital VTR integrated with a camera 201. Therefore, a still image to be transmitted to the printer 202 from the digital VTR integrated with a camera 201 is non-compression
10 encoded.

Also in the first embodiment, the expansion decoding unit 62 of the monitor 203 matches the encoding method of a moving image generated by the digital VTR integrated with a camera 201. Therefore, a
15 moving image to be transmitted to the monitor 203 from the digital VTR integrated with a camera 201 is compression encoded.

In the "record mode", in transmitting moving image data to an external apparatus, a user selects a moving
20 image from a desired time point with the operation unit 10 and instructs to transmit the moving image (Step S2001). The moving image data output from the image signal processing unit 6 is compression encoded in a predetermined manner by the compression/expansion unit
25 7, and the compressed image data is supplied to the memory 15. In parallel with this operation, of the moving image data output from the image processing unit

6, still images in the unit of several frames are supplied to the memory 13 without being compression encoded.

When the operation state of the digital VTR integrated with a camera 201 is set to the "reproduce mode", the recording/reproducing unit 8 selects desired moving images and reproduces them from the recording medium 19 (Step S2001). The desired moving images are selected in accordance with various instructions entered from the operation unit 10, and in accordance with these instructions, the system controller 9 controls the reproducing operation of the recording/reproducing unit 8. The compression encoded moving image data reproduced from the recording medium 19 is directly supplied to the memory 15. In parallel with this operation, the moving image data is expanded by the compression/expansion unit 7, supplied to the D/A converter 11, and stored in the memory 13 in the unit of several frames.

The moving image data stored in the memory 15 is read and supplied to the data selector 17 when necessary in order to transmit it in real time to the external apparatus, under the control of the memory controller 16. The still image data stored in the memory 13 is read and supplied to the data selector 17 when necessary in order to asynchronously transmit it to the external apparatus, under the control of the

memory controller 14. The read control by the memory controller 14 is controlled by the system controller 9 to start in response to an instruction (i.e., transfer request for still image) from the operation unit 10.

5 In the first embodiment, a user instructs to start
moving image communications by using a communication
mode start switch (not shown) or the like mounted on
the operation unit 10. In transmitting a still image
contained in the moving image data under transmission
10 to the printer 202 or the like, a user selects a
desired still image by operating upon the operation
unit 10 in a predetermined operation sequence. In this
manner, the still image is transmitted by being time
divisionally multiplexed with the moving image being
15 isochronously transmitted.

In the first embodiment, although the system controller 9 controls each process of the digital VTR integrated with a camera 201, it can also perform the following operation. Namely, it generates a control command for controlling the external apparatus (e.g., printer 202) connected via the 1394 interface 18 and 1394 serial bus and asynchronously transmitting it to the external apparatus via its 1394 interface 18. The 1394 interface 18 can receive control data transmitted from an external apparatus connected to the serial bus, and in accordance with the control data, the system controller 9 controls the operation of the digital VTR.

integrated with a camera 201. Therefore, for example,
it is possible for the monitor 202 to instruct a
transmission of a still image contained in the moving
image at a desired time point from the digital VTR
5 integrated with a camera 201 to the printer 202, by
using the operation unit 10.

The data selector 17 selectively outputs one of
the encoded moving image data output from the memory
15, the non-encoded still image data output from the
10 memory 13, and the control command data output from the
system controller 9, and supplies the selected data to
the 1394 interface 18.

The 1394 interface 18 transmits information data
such as moving and still images and control data for
15 controlling internal and external apparatuses, by using
a communication method in conformity with the 1394
serial bus. After an instruction of a communication
start entered from the operation unit, a moving image
taken with the digital VTR integrated with a camera 201
20 is isochronously transmitted to a number of undefined
external apparatuses at each predetermined
communication cycle (e.g., 125 μ s) over a reserved
transmission bandwidth (Step S2002). Specifically, the
moving image data in the unit of a predetermined data
25 amount is converted into an isochronous packet shown in
Fig. 16 and broadcast to the communication network.

Command data for selecting a still image to be

transmitted or controlling the operation of an external apparatus is transmitted irregularly to an object node designated by the operation unit 10 or by the external apparatus. For example, in transmitting and printing still image data at the object node printer 202 on the 1394 serial bus, a user designates the object node by operating upon the operation unit 10 in a predetermined operation sequence to thereby asynchronously transmit the still image data (Step S2003).

The still image data input to the 1394 interface 18 is converted into an asynchronous packet shown in Fig. 14 and transmitted to the designated object node. In the above manner, the digital VTR integrated with a camera 201 can transmit in real time the moving image data to all external apparatuses on the 1394 serial bus and can asynchronously transmit the still image data to only the designated object node (Step S2004).

Fig. 21 shows an example of time sequential transition of moving image and still image data transmitted over the 1394 serial bus.

Referring to Fig. 21, ch (channel). a represents moving image data transmitted in an isochronous transmission mode. A communication cycle (e.g., 125 μ s) of the 1394 serial bus is partitioned by a cycle start packet necessary for making generally coincident the values of cycle timers of apparatuses on the 1394 serial bus. After the cycle start packet, there is an

isochronous packet transmission period. The 1394 interface 18 transmits the moving image data ch. a packetized in accordance with a predetermined communication protocol, over the transmission bandwidth. The period after the isochronous transmission and before the next communication cycle is an asynchronous packet transmission period. During this period, the 1394 interface 18 transmits an asynchronous packet (including still image and command data) when necessary, reliably to a specific object node. In this manner, the isochronous packet (isochronous communication data) and asynchronous packet (asynchronous communication data) are time divisionally multiplexed in each predetermined communication cycle and transmitted over the 1394 serial bus.

The digital VTR integrated with a camera 201 of the first embodiment converts the compression encoded moving image data into an isochronous packet in conformity with the predetermined communication protocol, and isochronously transmits it as illustrated in Fig. 21. The non-compression encoded still image data contained in the moving image data is asynchronously transmitted as illustrated in Fig. 21. In this manner, the digital VTR integrated with a camera 201 can isochronously transmit moving image data in each predetermined communication cycle period and

can isochronously transmit still image data by time divisionally multiplexing it with the isochronous transmission. Similarly, the digital VTR integrated with a camera 201 can asynchronously transmit a control command for controlling the operation of an external apparatus on the 1394 serial bus. Namely, the 1394 interface 18 isochronously transmits moving image data in each predetermined communication cycle period and asynchronously transmits still image data when necessary by using an idle period of the predetermined communication cycle period, so that the serial bus can be efficiently used. The above processes are executed until the moving image data communication process is terminated (Step S2005).

The moving and still image data generated by the digital VTR integrated with a camera 201 is transmitted to each apparatus on the 1394 serial bus. The monitor 203 on the 1394 serial bus is previously set so that it can cover the transmission bandwidth (ch. a) used by the digital VTR integrated with a camera 201 and can receive the isochronous packet (containing moving image data) in the bandwidth. The moving image data contained in the received isochronous packet is supplied to the expansion decoding unit 62 which performs a decoding process suitable for the received moving image data. Thereafter, the moving image data is converted into an analog signal by the D/A converter

63 and displayed on CRT 64. In this case, the
operation unit 66 may be used to transmit a control
command for instructing to print a desired still image,
to the digital VTR integrated with a camera 201. In
5 response to this control command, the digital VTR
integrated with a camera 201 starts transmitting the
still image.

The 1394 interface 19 of the printer 202 receives
an asynchronous packet (containing still image or
10 control command) transmitted from the digital VTR
integrated with a camera 201, and supplies the received
data to the data selector 20. The data selector 20
supplies the received data to the printer controller 26
if it is a control command, or to the image processing
15 unit 28 if it is a still image. The image processing
unit 28 processes the still image so as to make it
suitable for printing, and thereafter the processed
still image is printed.

The printer 202 of the first embodiment is
20 configured to be able to print a non-compression
encoded and asynchronously transmitted still image.
Therefore, even if a printer cannot deal with the
encoding method used by the digital VTR integrated with
a camera 201, a high quality image can be printed with
25 a simple system configuration.

The digital VTR integrated with a camera 201 of
the first embodiment can transmit moving image data

taken therewith to display it on the monitor 203. A user can select a still image to be printed, while viewing the moving image displayed on the monitor 203. In accordance with this selection, the digital VTR integrated with a camera 201 asynchronously transmits a desired still image while transmitting the moving image in real time. In other words, the digital VTR integrated with a camera 201 can transmit time divisionally both the moving and still images.

As described above, according to the first embodiment, if a source node apparatus uses an encoding method corresponding to the decoding method at an object node apparatus, the source node can transmit image information encoded by this encoding method. If the source node apparatus is not provided with an encoding method corresponding to the decoding method at an object node apparatus, the source node can transmit decoded image information. In this manner, the use efficiency of a communication transmission path can be improved.

The digital VTR integrated with a camera 201 of the first embodiment can broadcast in real time compression encoded or non-compression encoded moving image information in accordance with the decoding performance of an object node. Similarly, compression encoded or non-compression encoded still image information can be transmitted reliably only to an

object node, in accordance with the decoding performance of the object node.

The communication system of the first embodiment can not only select still image information contained in moving image information without using an editing apparatus such as PC, but also print the still image information with ease and quickly, without imparting unnecessary load on other apparatuses.

2. Second Embodiment

In the first embodiment, compression encoded moving images are transmitted in real time by the isochronous transmission, and non-compression encoded still images are transmitted asynchronously by the asynchronous transmission.

In the second embodiment, compression encoded moving image is transmitted by the isochronous transmission, and a plurality frame of non-compression encoded still images are transmitted sequentially by the isochronous transmission.

In the second embodiment, the processing units having similar operations and functions to those of the first embodiment are represented by using identical reference numerals, and the description thereof is omitted.

With reference to Fig. 22, the structure of a communication system of the second embodiment will be described.

In Fig. 22, the structures of a digital VTR integrated with a camera 201 and a printer 202 are similar to those of the first embodiment. A monitor 204 has a selector 67 and an adder 68 in addition to
5 the structure of the monitor 203 of the first embodiment.

With reference to the flow chart shown in Fig. 23, an operation will be described in which moving image data taken with, for example, the digital VTR
10 integrated with a camera 201 is isochronously transmitted and a still image contained in the moving images is printed with the printer 202.

In the second embodiment, the decoding unit 21 of the printer 202 does not match the encoding method of a
15 still image generated by the digital VTR integrated with a camera 201. Therefore, similar to the first embodiment, a still image to be transmitted to the printer 202 from the digital VTR integrated with a camera 201 is non-compression encoded.

20 Also in the second embodiment, the expansion decoding unit 62 of the monitor 203 matches the encoding method of a moving image generated by the digital VTR integrated with a camera 201. Therefore, a moving image to be transmitted to the monitor 204 from
25 the digital VTR integrated with a camera 201 is compression encoded.

A user selects a moving image from a desired time

point with the operation unit 10 of the digital VTR integrated with a camera 201 (Step S2301).

The compression encoded moving image stored in the memory 15 is read so that it can be transmitted at each 5 predetermined communication cycle (e.g., 125 µs) after a communication start instruction from the operation unit 10 (Step S2302).

The non-compression still image stored in the memory 13 is read in response to an instruction from 10 the operation unit 10 or an external apparatus (Step S2303).

The still and moving image data of a predetermined data amount read under the control of the memory controllers 14 and 16 is alternately supplied via the 15 data selector 17 to the 1394 interface 18. The 1394 interface 18 converts the still and moving image data input in the unit of the predetermined data amount into isochronous packets and isochronously transmits them to the printer 202 and monitor 204 (Step S2304).

In the second embodiment, a plurality frame of 20 still images are isochronously transmitted. Therefore, the monitor 204 and printer 202 on the communication network can receive a plurality of still images transmitted from the digital VTR integrated with a 25 camera 201 generally at the same time and a desired still image can be displayed or printed at respective apparatuses.

The command data for controlling the operation of an external apparatus is irregularly and asynchronously transmitted to an object node designated by the operation unit 10 or by the external apparatus, similar 5 to the first embodiment.

Fig. 24 shows an example of time sequential transition of moving image and still image data transmitted over the 1394 serial bus.

Referring to Fig. 24, ch (channel). a represents 10 moving image data packetized in accordance with the isochronous transmission method. Similarly, ch. b represents still image data packetized in accordance with the isochronous transmission method.

After the cycle start packet is transmitted, the 15 moving image data and a plurality frame of still image data packetized in accordance with the predetermined communication protocol are transmitted via the 1394 interface over the transmission bandwidths of ch. a and ch. b. During the period after the isochronous 20 transmission and before the next communication cycle, the 1394 interface 18 transmits an asynchronous packet (including command data) when necessary. In this manner, the isochronous packet (isochronous communication data) and asynchronous packet 25 (asynchronous communication data) are time divisionally multiplexed in each predetermined communication cycle and transmitted over the 1394 serial bus.

The above processes are executed until the moving image data communication process is terminated (Step S2305).

In addition, in the second embodiment, the monitor 204 is previously set so that it can cover the transmission bandwidths (ch. a, ch. b) used by the digital VTR integrated with a camera 201 and can receive the moving and still image data isochronously transmitted from the digital VTR integrated with a camera 201.

Fig. 25 is a diagram showing an example of a display screen of the monitor 204. In Fig. 25, reference numeral 2501 represents a moving image display area for displaying moving images, reference numeral 2502 represents a still image display area for displaying a still image when necessary, and reference numeral 2503 represents an operation switch for instructing to display a desired still image contained in the displayed moving image.

The selector 67 of the monitor 204 selects either the moving or still image received via the 1394 interface 61 and supplies the selected image to the succeeding stage. The moving image data selectively output from the selector 67 is supplied to the expansion decoding unit 62 whereat the moving image data is expansion decoded and then supplied to the adder 68. On the other hand, a plurality frame of

still image data selectively output from the selector 67 is directly supplied to the adder 68, because the non-compression encoded still image data is not necessary to be expansion decoded. The adder 68 adds 5 the still image data to the moving image to synthesize them to display the still image in the still image display area in the moving image display area. An output of the adder 68 is supplied to the D/A converter 63 to display both the moving and still images on CRT 10 64 of the monitor 204.

With the structure constructed as above, a user can view both the moving and still images on the monitor 204. The user can therefore confirm the still image to be printed, on the monitor 204 together with 15 the associated moving image.

Similar to the first embodiment, the printer 202 of the second embodiment is configured to be able to receive and print a non-compression encoded still image data. Therefore, even if a printer cannot deal with 20 the encoding method used by the digital VTR integrated with a camera 201, a high quality image can be printed with a simple system configuration.

As described above, according to the second embodiment of the invention, if a source node apparatus 25 uses an encoding method corresponding to the decoding method at an object node apparatus, the source node can transmit image information encoded by this encoding

method. If the source node apparatus is not provided with an encoding method corresponding to the decoding method at an object node apparatus, the source node can transmit decoded image information. In this manner,
5 the use efficiency of a communication transmission path can be improved.

The digital VTR integrated with a camera 201 of the second embodiment can broadcast in real time compression encoded or non-compression encoded moving
10 images in accordance with the decoding performance of an object node. Similarly, a plurality frame of compression encoded or non-compression encoded still images can be sequentially broadcast, in accordance with the decoding performance of the object node.
15 Accordingly, the same still image can be transmitted generally at the same time to a plurality of apparatuses.

The communication system of the second embodiment can not only select a still image contained in moving
20 images without using an editing apparatus such as PC, but also print the still image with ease and quickly, without imparting unnecessary load on other apparatuses.

3. Third Embodiment

In the first and second embodiments, if a source
25 node apparatus uses an encoding method corresponding to the decoding method at an object node apparatus, image

information (including moving and still images) encoded by this encoding method is transmitted either by the isochronous or asynchronous transmission.

In the third embodiment, a source node apparatus
5 transmits in advance decode program information
realizing the decoding method corresponding to the
encoding method of the source node apparatus, to an
object node apparatus. In accordance with the decode
program information, the object node apparatus decodes
10 the image information asynchronously transmitted from
the source node apparatus. A communication system
realizing this will be described.

In the third embodiment, the processing units
having similar operations and functions to those of the
15 first and second embodiments are represented by using
identical reference numerals, and the description
thereof is omitted.

With reference to Figs. 26 and 27, the structure
of a communication system of the third embodiment will
20 be described.

Fig. 26 is a schematic diagram showing the
structure of the communication system of the third
embodiment. Referring to Fig. 26, a
recording/reproducing device (e.g., digital VTR
25 integrated with a camera) 205 and a printer 206 are
directly connected by an 1394 interface. Namely, the
apparatuses are connected in peer-to-peer. In this

communication system, the printer 206 prints image data (still image) transmitted from the recording/reproducing device 205. The recording/reproducing device 205 and printer 206 have 5 partially the same structures as those of the first embodiment.

Fig. 27 is a block diagram showing the detailed structures of the recording/reproducing device 205 and printer 206 of the third embodiment. With reference to 10 Fig. 27, the structures of the recording/reproducing device 205 and printer 206 of the third embodiment different from the first embodiment will be described.

In the recording/reproducing device 205 shown in Fig. 27, a ROM 74 stores program codes realizing an 15 expansion decoding method (e.g., MPEG, JPEG, DV (digital video), and the like) corresponding to a compression encoding method used by the compression encoding unit 7. A read control unit 73 operates to read the decode program information constituted of 20 program codes when necessary, and to transmit it via the data selector 17, 1394 interface 18 to an external apparatus.

The decode program information is transmitted by 25 the asynchronous transmission, or in some case, by the isochronous transmission. The transmission timing is set to a time before image data is transferred, or may be in one communication cycle together with image data

transmission.

Although the recording/reproducing device 205 of the third embodiment uses an integrated one compression encoding method for all image data to be stored, 5 another method may be used. For example, a plurality of compression encoding methods may be selectively used in the unit of an optional data amount or an optional time. In this case, ROM 74 stores decode program information corresponding to a plurality of decoding 10 methods. The recording/reproducing device 205 transmits the decode program information to object node apparatuses in a predetermined order.

In order to decode image data, the printer 206 receives decode program information transmitted before 15 the image data or in parallel with the image data, and stores it in an entirely or partially rewritable memory 71. The received compression encoded data is decoded by the decoding unit 72 by using the decode program information stored in the memory 71.

20 The memory 71 can store decode program information corresponding to an apparatus from which compression encoded data is transmitted. The decoding unit 72 can function as a plurality type of decoders, by using the memory 71. The decoding unit 72 may be structured so 25 that it cannot operate as a decoder unless it receive decode program information from another apparatus, or a predetermined decode program may be stored in a partial

area of the memory 71.

Compatibility of the transmitted/received decode program information is required between the recording/reproducing device 205 and printer 206. To this end, the decoding unit 72 is previously standardized and ROM 74 stores the decode program information written in accordance with the standards. Alternatively, only a method of writing the decode program information may be standardized, and the decoding unit 72 analyzes and executes the standardized decode program information.

With the structure constructed as above, compression encoded image data can be transmitted even if it does not match the decoding performance of the printer 206, and therefore a transmission efficiency thereof is better than that of non-compression encoded data.

In the third embodiment, time bomb data may be added to the decode program information transmitted to the printer 206 in order to automatically erase the decode program information after the print operation of a designated circuit is completed or after a predetermined time lapse. Such a function may be provided to the printer 206 itself, e.g., the printer controller 26. Furthermore, command data for erasing the decode program information may be transmitted from the recording/reproducing device 205, upon reception of

a completion notice of the print operation.

Fig. 28 is a flow chart illustrating the operation of the recording/reproducing device 205 according to the third embodiment.

5 First, at Step S21 a user designates an object node apparatus. In this embodiment, the printer 206 is designated. In response to this designation, transmission setting is performed.

10 Next, the user selects image data (still image) to be printed, from the images stored in the recording medium. At Step S22, the recording/reproducing device 205 reads the selected image. After this selected image read operation, at Step S23 the user is urged to issue a transmission instruction for the desired image.

15 It is judged at Step S24 whether decode program information necessary for decoding the image data given the transmission instruction is required to be transmitted to an object node apparatus (in this case, printer 206). If required, i.e., if it is judged that 20 the decoding unit 72 of the printer 206 can decode compression encoded image data by using the decode program information, then at Step S25 necessary decode program information is read from ROM 74 and transmitted to the printer 206.

25 The printer 206 stores the received decode program information in the memory 71.

If it is judged at Step S24 that transmission is

not necessary, i.e., if the object node printer 206 has already necessary decode program information or if the necessary decode program transmitted in the past is being stored in the memory 71, then the decode program 5 information is not transmitted and the image data starts being transmitted.

The information used for judging whether decode program information is required to be transmitted to the printer 206 can be acquired by returning from the 10 printer 202, in response to a request from the recording/reproducing device 205, information of the decode program information possessed by the printer 202.

Next, at Step S26 the compression encoded image 15 data given the transmission instruction is read from the recording medium 19, output to the memory 15 and transmitted to the printer 206.

Upon reception of the compression encoded data, the printer decodes it in accordance with the already 20 stored decode program information to start the printing operation of the image data. If the decode program information is not still transmitted, the encode data starts being decoded after the transmission completion.

At Step S27, after the desired image data is 25 transmitted, a predetermined process necessary for the transmission completion is performed. It is checked at Step S28 whether other image data is to be transmitted.

If other image data is selected, the processes at Step S22 and following Steps are repeated. If other image data is not selected, the flow is terminated. This flow starts from Step S21 at any time in response to a
5 transmission request for image data.

In the third embodiment, although compression encoded image information transmitted from the recording/reproducing device 205 to the printer 206 is a still image, the invention is not limited only
10 thereto. For example, if the recording/reproducing device 205 is connected to a display unit such as a monitor 203, 204, compression encoded moving images may be transmitted. In this case, the display unit is required to have components similar to the memory 71
15 and decoding unit 72 of the printer 206.

In the third embodiment, although the transmission method for a still image is the asynchronous transmission similar to the first embodiment, the isochronous transmission may be used similar to the
20 second embodiment. The latter case is convenient if a plurality of still images are sequentially transmitted or the same moving image is transmitted to a plurality of apparatuses.

As above, according to the third embodiment, a
25 source node apparatus transmits in advance decode program information realizing a decoding method corresponding to the encoding method to be used by the

source node apparatus, to an object node apparatus. Accordingly, image information (including moving and still images) to be transmitted to and from each apparatus is always compression encoded image data so 5 that the use efficiency of a communication transmission path can be improved. Furthermore, the capacity of a memory for storing received image information can be reduced.

Irrespective of the type of a decoding method at 10 an object node, the recording/reproducing device 205 of the third embodiment can transmit compression encoded still image data only to a designated object node apparatus, when necessary. Furthermore, the same still image can be transmitted generally at the same time to 15 a plurality of apparatuses.

The communication system of the third embodiment can print a selected still image with ease and rapidly without using an editing apparatus such as PC.

4. Fourth Embodiment

20 In the third embodiment, an object node apparatus matches decode program information to be transmitted from a source node apparatus.

In the fourth embodiment, in accordance with the decoding performance at an object node apparatus, a 25 source node apparatus transmits encoded image information, non-encoded image information, or encoded image information and decode program information. This

case of the fourth embodiment will be described hereinunder.

In the fourth embodiment, the processing units having similar operations and functions to those of the 5 first to third embodiments are represented by using identical reference numerals, and the description thereof is omitted.

With reference to Figs. 26 and 27, the structure of a communication system of the fourth embodiment will 10 be described.

Referring to Fig. 26, the recording/reproducing device 205 requests the printer 206 for the decoding performance (hereinafter called decode information) of the printer 206. If it is judged from the decode 15 information that the memory 71 is storing decode program information corresponding to the encoding method to be used by the recording/reproducing device 205, then the system controller 9 controls the memory controller 16 to read desired image information 20 (compression encoded moving or still image) from the memory 15. The image information read from the memory is transmitted by the isochronous transmission if it is a moving image, or by the asynchronous transmission if it is a still image.

If it is judged from the decode information that although a decoding process using the decode program information is possible, the memory 71 does not store 25

decode program information corresponding to the
encoding method to be used by the recording/reproducing
device 205, then the system controller 9 controls the
read control unit 73 to asynchronously transmit the
5 decode program information stored in the memory 74.
Thereafter, the system controller 9 controls the memory
controller 16 to read desired image information
(compression encoded moving or still image) from the
memory 15. The image information read from the memory
10 is transmitted by the isochronous transmission if it is
a moving image, or by the asynchronous transmission if
it is a still image.

If it is judged from the decode information that a
decoding process corresponding to the encoding method
15 to be used by the recording/reproducing device 205 is
not possible and that a decoding process using the
decode program information is not serviceable, then the
system controller 9 controls the memory controller 14
to read desired image information (compression encoded
20 moving or still image) from the memory 13. The image
information read from the memory 14 is transmitted by
the isochronous transmission if it is a moving image,
or by the asynchronous transmission if it is a still
image.

25 With the structure constructed as above, the
recording/reproducing device 205 can transmit
compression encoded image information as much as

possible so that the transmission efficiency is better than that of non-compression encoded image information. It is also convenient since non-compression encoded image information can be transmitted even if 5 compression encoded image information cannot be transmitted.

Fig. 29 is a flow chart illustrating the operation of the recording/reproducing device 205 of the fourth embodiment.

10 At Step S31, as a user designates an object node apparatus (e.g., printer 206), and the recording/reproducing device 205 performs transmission setting corresponding to the designation. At Step S32 the recording/reproducing device 205 asynchronously 15 transmits a command requesting decoder information (information of a presence/absence, type, configuration and the like of the decoder of the printer 205), by using the 1394 bus. Upon reception of the command issued at Step S32, the printer 206 asynchronously 20 transmits predetermined transmission confirmation command data including decoder information to the recording/reproducing device 205.

At Step S33 the system controller 9 of the recording/reproducing device 205 judges whether the 25 decoder information has been received. If received, the flow advances to Step S34.

If the printer 206 has no decoder function or it

cannot transmit decoder information, if the command including decode information is not returned, or if the command is not received even after a predetermined time lapse because of transmission error on the bus or
5 asynchronous transmission delay, then the recording/reproducing device 205 executes Step S40 in order to transmit only non-compression encoded data.

Next, at Step S34 the encoding performance of the printer 206 is checked from the decoder information.
10 If it is judged that the printer 206 can deal with all encoding methods to be used by the recording/reproducing device 205, Step S35 is executed. If it is judged that compression encoded data can be decoded if predetermined decode program information is
15 transmitted, Step S45 is executed. If compression encoded data cannot be decoded because the printer 206 cannot process the decode program information, cannot deal with the encoding method to be used by the recording/reproducing device 205, or has no decoding means, or because of other reasons, then Step S40 is
20 executed.

The decode information transmitted from the printer 206 to the recording/reproducing device 205 is used for selecting either a mode of transmitting
25 compression encoded image data itself, a mode of transmitting non-compression encoded image data, or a mode of transmitting compression encoded image data

together with the decode program information. The decode information has a roll of judging which transmission mode the printer 206 requests. If predetermined information is previously notified between nodes, the decode information in the Step 32 can be used as a command for requesting compression encoded data transmission, non-compression encoded data transmission, or decode program information transmission.

If the decoding unit 72 of the printer 206 can deal with any compression encoding method to be used by the recording/reproducing device 205, Step S35 and following Steps are executed.

At Step S35 a user selects desired image data (still image) from the moving image stored in the recording medium 19, and the recording/reproducing device 205 performs a read operation for the selected image data. At Step S36 the user instructs to transmit the selected image. At Step S37, in order to transmit the designated image data in the form of compression encoded image data, the designated image data is reproduced from the recording medium 19 and asynchronously transmitted to the printer 206 via the frame memory 15. In accordance with a predetermined operation sequence, the printer 206 decodes the image data and starts the print operation.

When the desired image data is transmitted at Step

S38, it is judged at Step S39 whether other image data is to be transmitted. If to be transmitted, Step S35 and following Steps are repeated, whereas if not to be transmitted, the flow terminates.

5 If the image data cannot be decoded because of the configuration of the printer 206 or the like, non-compression encoded data is always transmitted. In this case, the recording/reproducing device 205 performs Step S40 and following Steps.

10 At Step S40 a user selects desired image data (still image) from the moving image stored in the recording medium 19, and the recording/reproducing device 205 performs a read operation of the selected image data. At Step S41 the user instructs to transmit 15 the selected image. At Step S42, the designated image data is converted into non-compression encoded data by the compression/expansion unit 7 and asynchronously transmitted to the printer 206 via the frame memory 13. In accordance with a predetermined operation sequence, 20 the printer 206 decodes the image data and starts the print operation.

When the desired image data is transmitted at Step S43, it is judged at Step S44 whether other image data is to be transmitted. If to be transmitted, Step S40 25 and following Steps are repeated, whereas if not to be transmitted, the flow terminates.

If the decoding unit 72 of the printer 206 can

decode compression encoded data by using predetermined decode program information, Step S45 and following Steps are executed in order to transmit the decode program information and compression encoded data.

5 At Step S45 a user selects desired image data (still image) from the moving image stored in the recording medium 19, and the recording/reproducing device 205 performs a read operation of the selected image data. At Step S46 the user instructs to transmit
10 the selected image.

At Step S47 it is judged whether predetermined decode program information is to be transmitted to the object node printer 206 to decode the image data. If to be transmitted, at Step S48 necessary decode program
15 information is read from ROM 47 and asynchronously (or isochronously) transmitted to the printer 206. The printer 206 stores the received decode program information in the memory 71. The decoding unit 72 performs a decoding process by using the memory 71.

20 If it is judged at Step S47 that it is not necessary to transmit the decode program information, because the printer 206 has already hardware or software decoding means or the necessary decode program information has already been stored in the memory 71,
25 then the decode program information is not transmitted and the image data is transmitted.

At Step S49, the desired image data in the form of

compression encoded data is read from the memory 16 and asynchronously transmitted to the printer 206. In accordance with a predetermined operation sequence, the printer 206 decodes the transmitted image data by using
5 the transmitted decode program information and starts the print operation.

When the desired image data is transmitted at Step S50, it is judged at Step S51 whether other image data is to be transmitted. If to be transmitted, Step S45
10 and following Steps are repeated, whereas if not to be transmitted, the flow terminates.

After the process at Step S39, S44, or S51, in response to a request for image data transmission, the flow returns to Step S31 to repeat this flow.

15 In the fourth embodiment, although image information transmitted from the recording/reproducing device 205 to the printer 206 is a still image, the invention is not limited only thereto. For example, if the recording/reproducing device 205 is connected to a
20 display unit such as a monitor 203, 204, compression encoded or non-compression encoded moving images may be transmitted. In this case, the display unit is required to have components similar to the memory 71 and decoding unit 72 of the printer 206. Furthermore,
25 if a plurality frame of still images are to be sequentially transmitted, these still images may be isochronously transmitted.

As above, according to the fourth embodiment, a source node apparatus selects a suitable mode in accordance with the decoding performance of an object node apparatus, from a mode of transmitting encoded image information, a mode of transmitting non-encoded image information and a mode of transmitted encoded image information and decode program information.

Accordingly, image information (including moving and still images) to be transmitted to and from each apparatus is compression encoded in accordance with the decoding performance of an object node apparatus so that the use efficiency of a communication transmission path can be improved. Furthermore, the capacity of a memory for storing compression encoded image information received at an object node apparatus, can be reduced.

The recording/reproducing device 205 of the fourth embodiment can transmit compression encoded still image data only to a designated object node apparatus, when necessary, in accordance with the decoding performance at an object node apparatus.

The communication system of the fourth embodiment can print compression encoded image information with ease and rapidly without using an editing apparatus such as PC, in accordance with the decoding performance of an object node apparatus.

5. Other Embodiments

The process sequence of each apparatus of the communication system of the first to fourth embodiments can be realized by software.

For example, the embodiments of the present invention may be realized, by configuring that a storage medium storing program codes of software realizing the functions of each embodiment is supplied to a controller (including a microcomputer) of the system or apparatus of each embodiment, or by configuring that a controller of the system or apparatus of each embodiment reads the program codes stored in the storage medium and controls the system or apparatus so as to realize the functions of each embodiment.

For example, the program codes realizing the processes and functions of the first and second embodiments shown in Fig. 19, the third embodiment shown in Fig. 28 and the fourth embodiment shown in Fig. 29 are stored in storage media of the system controller 9 shown in Figs. 18, 22 and 27. The system controller 9 itself reads the program codes to operate each process unit of the recording/reproducing devices 201 and 205 shown in Figs. 18, 22 and 27 to realize the functions of the embodiments.

In this case, the program codes themselves read from a storage medium realize the functions of the embodiments. Therefore, the storage medium storing the

program codes constitutes the present invention.

The storage medium storing such program codes may be a floppy disk, a hard disk, an optical disk, a magneto-optical disk, a CD-ROM, a CD-R, a magnetic tape, a non-volatile memory card, and a ROM.

Obviously, the invention includes the case wherein the embodiment functions are realized by an OS (operating system), application software or the like which controls the system or apparatus of the 10 embodiments in accordance with instructions of the program codes read from a storage medium.

Obviously, the invention includes the case wherein the embodiment functions are realized by writing the program codes read from a storage medium into a memory 15 of an expansion board or unit connected to a controller which controls the operation of the system or apparatus of the embodiments in accordance with the program codes.

The invention may be embodied in other specific 20 forms without departing from the spirit or essential characteristics thereof.

For example, in the above embodiments, although image information recorded in the recording medium 19 is encoded or non-encoded and transmitted, the 25 invention is not limited thereto, but image information picked up with the image pickup unit 4 and generated by the image signal processing unit 6 may be encoded or

non-encoded and transmitted.

In the above embodiments, a digital VTR integrated with a camera and dealing moving and still images is used as an example of the recording/reproducing device 5 201, 205. Other recording/reproducing devices may also be used which can record/reproduce digital data (e.g., audio data) such as moving images desired to be transmitted in real time and digital data (e.g., file data) such as still images not desired to be 10 transmitted in real time. These devices may be storage devices, DVD (digital video disc) players, CD-ROM players and the like.

In the above embodiments, although the communication system is configured by using digital 15 interfaces in conformity with IEEE 1394 specifications, the invention is not limited thereto. For example, communication interfaces using two communication transmissions corresponding to isochronous and asynchronous transmissions may be used.

Therefore, the above-mentioned embodiments are merely examples in all respects, and must not be construed to limit the invention.

The scope of the present invention is defined by the scope of the appended claims, and is not limited at 25 all by the specific descriptions of the specification. Furthermore, all the modifications and changes

belonging to equivalents of the claims are considered to fall within the scope of the present invention.